



## Membrane System for Recovery of Volatile Organic Compounds from Remediation Off-Gases



**Developer:** Membrane Technology & Research, Inc.  
**Contract Number:** DE-AR21-96MC33081  
**Crosscutting Area:** ESP

**Mixed Waste**  
**FOCUS AREA**

### Problem:

The Department of Energy (DOE) is responsible for remediation and waste management at numerous sites. Many sites contain volatile organic compound (VOC)-contaminated soil and groundwater; at others, large volumes of mixed low-level wastes contaminated with VOCs await processing. Remediation processes frequently produce off-gases containing water vapor and toxic levels of VOCs. Treatment of these off-gases is often a major portion of the total remediation cost. Carbon adsorption and catalytic incineration, the most common methods of treating these gas streams, suffer from significant drawbacks.

### Solution:

Membrane Technology & Research, Inc.'s (MTR's) membrane-based off-gas treatment technology separates the organic components from the off-gas stream, producing a VOC-free air stream that can be discharged or recycled to the gas-generating process. The membrane system produces a constant, high-quality air discharge stream irrespective of the feed-air composition. The system also produces a concentrated liquid VOC stream for disposal. Any water



vapor present in the off-gas is removed as condensed dischargeable water.

### Benefits:

- ▶ Applicable to a broad range of off-gas generating sources; target streams are off-gas from soil remediation by in situ vacuum extraction or air and steam sparging, and soil vitrification
- ▶ Suitable for remote sites: systems require minimal site preparation, little operator attention once installed, electrical power but no other utilities, and no expendable

chemicals

- ▶ Minimizes waste volume: dischargeable air and water are produced, and VOCs removed from the feed gas are concentrated into a condensed liquid; no other waste streams result
- ▶ Treats off-gases containing both flammable and nonflammable, and chlorinated and nonchlorinated VOCs
- ▶ Cost competitive with other technologies in the VOC concentration range 100-1,000 ppm and offers significant cost reduction



at higher VOC concentrations

- Systems are easily moved and transported to new sites with a minimum of refurbishing or modification

- Generates no air emissions, minimizing permitting issues and speeding up the start of a clean-up operation

### Technology:

Removal of VOCs from air streams with membranes is a relatively new technology. The technology is based on selective polymer membranes that preferentially permeate organic compounds, producing a clean air stream and a VOC concentrate. To date, most membrane systems have been installed on process streams in the chemical and petrochemical industries. Off-gases produced in DOE remediation operations are much less concentrated in VOCs than the chemical plant streams. However, a pilot test on an off-gas containing carbon tetrachloride (CCl<sub>4</sub>), produced by in situ vacuum extraction of soil, demonstrated the potential of the technology for remediation operations. The gas was saturated with water and contained 200-1,000 ppm CCl<sub>4</sub>. The membrane system consistently achieved greater than 95% VOC removal, producing dischargeable air containing less than 20 ppm VOC.

This project focuses on some key improvements needed for this process to become viable as an off-gas treatment option for DOE. In particular, since many off-gas streams contain low concentrations of VOCs and are saturated with water, an efficient method of separating the VOCs from the water is required to reduce the volume for disposal.

The membrane technology is best applied to VOC-containing air streams containing between 100 and 10,000 ppm VOC, whereas below 100 ppm VOC, carbon adsorption using replaceable carbon canisters may be most efficient. Thus, in many projects, the membrane system would be used for the first few months of operation as the VOC concentration declines from 10,000 to 100 ppm, after which carbon adsorption canisters would be used.

### Contacts:

MTR develops membrane separation processes for industrial and environmental applications, including removal of VOCs from air and water and natural gas separations. Systems for recovery of organics from air are sold under the trade name VaporSep®. For information on this project, the contractor contact is:

Principal Investigator:

Dr. J. G. Wijmans  
Membrane Technology & Research, Inc.

1360 Willow Road  
Menlo Park, CA 94025-1516  
Phone: (650) 328-2228 Ext. 118  
Fax: (650) 328-6580

E-mail: [wijmans@mtrinc.com](mailto:wijmans@mtrinc.com)

DOE's Federal Energy Technology Center supports the Environmental Management - Office of Science and Technology by contracting the research and development of new technologies for waste site characterization and cleanup. For information regarding this project, the DOE contact is:

DOE Project Manager:

Mr. William J. Huber  
Federal Energy Technology Center  
3610 Collins Ferry Road  
P.O. Box 880  
Morgantown, WV 26507-0880  
Phone: (304) 285-4663  
Fax: (304) 285-4403  
E-mail: [whuber@fetc.doe.gov](mailto:whuber@fetc.doe.gov)

